150.1	Special Borrow	Cubic Meter
170.	Fine Grading and Compacting - Subgrade Areas	Square Meter

SECTION 190

BORINGS

DESCRIPTION

190.20 General.

This work shall consist of making soil-test borings, obtaining and preserving acceptable samples, preparing a report of the results obtained and delivery of the report and samples.

The Engineer will establish the location and provide the ground surface elevation for each boring. No change in boring locations shall be made unless prior consent of the Engineer is obtained. The Contractor shall complete the borings to the specified highest bottom elevations or as directed. The actual location at which each boring is made shall be shown on the plans and the actual starting grade shown on the boring log.

The Contractor shall confine his/her operation as closely as possible to each location where work is to be performed. The Contractor shall take precautions necessary to prevent damage to existing structures and conduits both above and below ground, and to lawns, walks and pavements.

When the work at each borehole is completed, the hole shall be adequately blocked and solidly filled to a depth of at least 1.5 meters in a manner to preclude any possibility of injury to man or animal, or damage to property. Special Provisions for backfilling boreholes on railroad property may also be employed in accordance with railroad requirements.

Boreholes within the limits of travel ways, shoulders, sidewalks and paved areas shall be backfilled and compacted with granular materials and brought to the grade of the adjacent surface with a minimum of 150 millimeters of bituminous concrete or cement concrete, whichever is applicable.

The Department reserves the right, at any time during the life of the Contract, to determine the order in which remaining borings are to be taken and reserves the right to eliminate borings from, or to add borings to those shown on the plans and the right to increase or decrease the depth of any and/or all borings.

The Contractor shall be responsible for any claims resulting from damage to underground pipes, conduits, and structures. It is suggested that possible damage to such utilities can be minimized or eliminated by hand augering the first several meter of each borehole. The Contractor's attention is called to Subsection 7.13 of the Standard Specifications regarding Protection and Restoration of Property.

190.21 Boring Samples and Reports.

All Borings including Trial Borings, Auger Borings, Wellpoints and Test Pits shall require boring logs and/or records. Four copies of the typewritten boring report shall be submitted to the Research and Materials Engineer within ten (10) calendar days after completion of the work at each site. One (1) copy shall be on transparent paper (onion skin, vellum, etc.) from which satisfactory prints can be made. Abbreviations shall not be used on the final typewritten log.

Boring samples, packaged, packed and labeled as required and described hereinafter under each type of boring and sample, shall be delivered at the time the boring report is submitted, transportation prepaid, to the Research and Materials Engineer, Massachusetts Highway Department, 400 D Street, South Boston, Massachusetts 02210-1953.

In advance of shipment of boring samples, a letter of transmittal shall be sent to the Research and Materials Engineer, with a copy of the boring report and one copy of the Boring Record Cards as required in Subsection 190.61. A supply of Boring Record Cards for Department projects may be obtained upon request from the Research and Materials Engineer.

Where Control Borings are specified on the plans or in the Special Provisions, a legible copy of the driller's field

log shall be forwarded to the Research and Materials Engineer or as directed in the Special Provisions the day after the Control Boring work at each site is completed.

The original drillers field log (copy) will be submitted to the Research and Materials Engineer with the drillers field description unaltered. Should the Contractor's office engineer or geologist after review find it necessary to change a description he/she shall do so on a separate copy of the field log, date, sign, and clip the copy to the original driller's log. Copies of these logs shall be sent to the Research and Materials Engineer, District Highway Engineer and all others concerned. The field logs shall be sent to all concerned no later than one (1) day after the completion of each borehole.

190.22 Supervision.

The work shall be performed under the supervision of the authorized representative of the Engineer. No subsurface exploratory work shall be done in the absence of the Inspector.

The Contractor shall furnish the means and the men required to transport safely the Inspector to and from high ground and the position of borings located on water, in a swamp, or other surface conditions over which it is impossible or difficult to travel on foot.

The Contractor shall notify the Research and Materials Engineer and the District Highway Engineer, who is supplying the inspector, not less than forty eight (48) hours in advance of when he/she intends to commence work at a particular job site or when he/she intends to increase or decrease the number of rigs on a project in order that the Engineer may have time to provide a proper number of inspectors for the project.

190.23 Driller Qualifications.

The driller of each boring crew shall be responsible for determining changes in the soil. The driller shall be experienced in detecting variations in the soil by changes in the feel and sound of the hollow rod to which the bit is attached. The driller shall also be competent to classify the recovered soil samples in accordance with the Department's Visual Identification of Soils Table (copies may be obtained from the Research and Materials Engineer).

Before beginning on the Department's work, the Contractor shall certify in writing to the Engineer, the name of each driller he/she proposes to use. The driller shall be qualified as acceptable to the Engineer by exhibiting satisfactory abilities using the methods defined herein.

Once qualified a driller need not be requalified for subsequent projects, although approval must be obtained for his/her employment on each Contract. The Engineer reserves the right to determine the acceptability of the driller at any time during the prosecution of the work. The Contractor shall designate a field supervisor on each Project.

DRILLING METHODS

190.60 General.

A. Starting Boring

Every boring shall start as a Drive Sample Boring, except Hollow Stem Auger, Auger, Undisturbed Sample Preparatory, and Vane Shear Test Preparatory Borings.

Where the resistance to penetration with earth boring tools, as defined herein by "Practical Refusal" (Section F.), is encountered above the specified highest bottom elevation, the borehole nevertheless shall be made to said elevation. Should bedrock be encountered above the specified highest bottom elevation, the borehole shall be continued as a rock core boring for 3 meters unless otherwise directed.

B. Casing

Casing shall be of a size that will permit the specified soil sample or rock core to be obtained, or groundwater observation well to be installed, or to allow for telescoping and spinning of casing. All pieces of casing and wash-pipe shall be equal in length. Casing may be driven into the ground only so far as is necessary to keep the wall of the borehole in place and then open hole techniques may be employed. However if the Contractor so elects, casing may be used throughout the borehole as required. Casing for rock core borings shall be sealed on bedrock to prevent loose material from entering the hole and to prevent the loss of drilling fluid return, regardless of the type or types of material

encountered. Except for the first piece, when starting each borehole, the bottom of the casing should not be advanced below the bottom of the borehole that has been made with a chopping or drilling bit without the approval of the Engineer.

C. Making the Borehole

Independent of whether casing or open hole techniques are employed, the borehole shall be started and made by loosening the soil with a bit attached to the lower end of a hollow rod and given a chopping motion with a clockwise twist at the bottom of each stroke. An auger, either hand or power driven, a well-drill or a rotary drill shall not be used for advancing the borehole in less than "Dense" or "Very Dense" or "Practical Refusal" soil. However when casing is used a rotary bit may be used to clean the casing. A sampler shall not be used instead of a chopping or drilling bit for making a borehole. To make a borehole through "Dense", "Very Dense" or "Practical Refusal" soil, boulders, rockfill or other similar material the Contractor may employ whatever method he/she chooses, including roller bits, telescoping and spinning of a casing without endangering life and property or affecting the purpose for which the boring is being made. The Contractor shall not use a backhoe or other earth moving equipment without the express approval of the Engineer to start a boring. The soil thus loosened shall be borne to the surface in a liquid which is forced down through the hollow rod, out through the discharge ports in the bit, and up the annular space between the hollow rod and the wall of the borehole and/or casing. Except when preparing the borehole for special sampling, the discharge ports shall direct the flow downward. The returning liquid shall be discharged into a settling basin and shall be reused (recirculated) to form a native mud. Water alone, for transporting the loosened soil, shall not be used except at the very beginning of each borehole. If a contractor elects to use open hole techniques, an effective mud for the purpose of transporting out the loosened soil and for stabilizing the wall and bottom of the borehole may be manufactured by adding a fat clay or bentonite, or one of its derivatives, in sufficient amount, to the native mud. When making boreholes in very porous material, the Contractor may, with the prior consent of the Engineer, drive casing to seal the wall of the borehole. The volume of mud to be calculated at any time shall be no more than is necessary to transport the loosened soil, but in no event more than 40 liters per minute when making the borehole in 63.5 millimeter casing. No rig shall be removed from its position above the borehole nor shall the casing be pulled from the hole until the inspector has been shown a copy of the field log for that hole and has approved the removal of the rig and/or of the casing.

D. Changes in Soil

At each change in soil, as detected by the driller with intervals not to exceed those as stated under Item 190.61, the drilling operation shall cease and the borehole conditioned for sampling by slowing the pump, raising the bit off the bottom and circulating the liquid to remove from suspension large particles which might become settled solids and thus a part of the sample. The bit on the bottom end of the hollow rod shall then be replaced with a 34.9 millimeter inside diameter split-tube sampler which shall be entered into the undisturbed soil at the bottom of the borehole for the sample.

E. Obstructions

Should an obstruction be encountered in a drive sample boring, the Engineer may require the Contractor to make additional borings at locations to be determined by the Engineer to attempt to pass the obstruction and complete the boring. "Practical Refusal", boulders, hard material or rock fill will not be considered an obstruction. Final determination when and if an obstruction is encountered shall be made by the Engineer. Borings terminating on obstructions shall be considered trial borings and paid as a drive sample boring.

F. "Practical Refusal"

The term "Practical Refusal" shall mean failure of the sampler to penetrate at least 300 millimeters, when driven 120 blows using a 63.5 kilogram mass, free-falling 760 millimeters. In each case the Engineer by observation shall determine that a Practical Refusal actually has been encountered. A Practical Refusal will not be accepted as the termination of a borehole above the highest bottom elevation as specified on the plans or stated elsewhere.

190.61 Drive Sample Borings.

Control Borings and Complementary Borings, when required for design and/or construction purposes, shall be started as drive sample borings and compensated for as hereinafter provided. Control Borings should be completed and boring reports on same submitted as specified under Subsection 190.21 before any Complementary Borings are started. All, some, or none of the Complementary Borings may be required, depending on analysis of the Control Boring Data.

A sample shall be obtained at the beginning of each borehole and at each change in:

a. soil

b. consistency of a plastic stratum

c. density of a granular stratum

In addition to the above, samples shall be taken so that no sampling interval exceeds 1.5 meters in a continuous stratum. However the sampling procedure of obtaining a sample at each change as specified will take precedent.

In addition to taking the samples as mentioned, a sample shall also be obtained at specific elevations for certain borings when shown on the boring plans. These samples from certain elevations shall be placed in as many 120 milliliter jars as necessary to accommodate the contents of the entire sample recovered from the split spoon sampler and all jars shall be properly labeled and preserved as specified in the Standard Specifications. If a sample is lost during the recovery then the borehole shall be sampled again to recover a suitable sample at the specific elevation (or as close to it as possible) as given on the plans for certain borings. An acceptable minimum size sample shall be at least 150 millimeters in length. This requirement shall not apply if bedrock is encountered above the specified elevation.

A sampler of the size and type specified in Subsection 190.60D shall be driven to obtain the sample. Between each blow of the drive-weight, the sampler shall be turned clockwise at least one-quarter of a revolution to keep it free.

In no event will washed, bucketed, or bobbed samples be accepted.

Before sampling, the driller shall mark the drill rods in three successive 150 millimeter increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 150 millimeter increment.

During the sampling operation, the driller of the boring crew shall count and record the number of blows required to effect each 150 millimeter increment of penetration or fraction thereof for a distance of
450 millimeters using a of 63.5 kilogram mass free-falling 760 millimeters.

The number of blows required to effect each 150 millimeters of penetration or fraction thereof for a distance of 450 millimeters shall be recorded on the field log and final log.

The first 150 millimeters shall be considered to be the seating drive. The summation of the number of blows for the second and third 150 millimeter increments of penetration shall be the penetration resistance (N).

The blow counts shall be shown on the final boring log as recorded in 150 millimeter increments or fraction thereof, if the sampler fails to penetrate the 150 millimeters, with the corresponding sample depth.

The borehole shall be kept completely full of drilling liquid during the sampling and recovery operation.

Each sample, immediately upon its recovery, shall be placed (not jammed) in a 120 milliliter glass jar. Sample jars shall be of the same diameter for their full length and shall have screw tops fitted with gaskets. Samples of cohesive soils shall be struck even with the top of the jar. Jars containing samples shall be stored in a cool, damp place, free from exposure to frost or excessive heat. Each jar shall be properly labeled and its lid marked to identify its contained sample. The labeling shall be typewritten and the label glued to the side of the jar.

These labels shall show the following information in a neat, legible manner:

Name and address of boring contractor.

Date the boring was made.

Location and name of project.

Number of each boring as shown on the boring plans and log.

Number of the sample as shown on the boring log.

Depth at which the sample was obtained.

Number of blows required to drive the sampler 300 millimeters, using a 63.5 kilogram mass free- falling 760 millimeters.

Brief description of the classification of the material composing the sample.

All jars shall be packed one tier in clean, unused, substantial, partitioned paperboard cartons. Each carton shall contain exactly 24 jars. If the number of jars containing soil samples is less than 24, the remaining spaces in the carton shall be filled with empty jars.

In each carton the jars shall be arranged in successive order as the samples were obtained from each borehole, starting in the upper left hand corner, which shall be clearly identified with a felt tip marker on the outside, then moving from the top to the bottom of each succeeding row until all compartments have been filled. Jars left over to complete a borehole shall be similarly arranged, starting in the next numbered carton. Cartons shall be numbered successively on both ends with a felt tip marker. On both ends of each carton shall be glued a typewritten paper label, containing in the same format the information required on the boring Record Cards, which fully describes its contents.

Each driller shall sign only the notes for the borings he/she has made. These notes shall be preserved by the Contractor for future reference. The Inspector shall sign the field copy of the notes also.

At the completion of the boring work, the Contractor shall prepare a boring report containing a graphic representation (or log) of the results obtained. The log for each boring shall be a continuous vertical column, without discontinuity or offset and plotted to not less than a 1:100 scale. The logs for all borings for each structure or construction unit shall be plotted to the same scale, on a type of transparent paper such as onion skin, size A4, and contain one log per sheet.

The boring report shall contain the following minimum information and be typewritten:

(1) Date, location and name of project.

(2) Boring number or other designation.

(3) Survey station and offset.

(4) Starting grade of each boring (to be supplied by the Engineer).

(5) Depth and a brief, proper classification by visual and manual inspection of each type of material including rock successively encountered in each borehole. Granular soils shall be classified by apparent grain size and state of denseness; clay soils by color and state of consistency, either as hard, medium or soft, and silts as organic or inorganic all in accordance with the Department's Visual Identification of Soils Table. Abbreviations shall not be used on the final typewritten log.

(6) The resistance offered to penetration of the sampler, when sampling each stratum of soil, as represented by the number of blows required to drive the specified sampler 300 millimeters, or the designated fraction or multiple thereof, with a 63.5 kilogram mass free falling 760 millimeters.

(7) Special Note "CHANGED LOCATION" shall be made on each boring log to indicate any field change from survey layout, and an explanation of the reason for the change.

(8) Distance below starting grade to the surface of water in the borehole at its completion and at other times (if any) as required in the Special Provisions, and any unusual behavior of ground-water observed during the boring operation.

(9) Every unusual condition noted during the entire operation. When boulders or cobbles are encountered the driller shall note this on the log and how the boring was made through the boulders or cobbles.

(10) Below each boring log shall be noted the hour and date of start and completion, the actual hours worked to complete the borehole and the name of the driller and inspector.

190.62 Hollow Stem Auger Borings.

This type of Boring, when specified by the Engineer will be made in accordance with the specifications and the special provisions of the Contract. When Hollow Stem Augers are used the type samplers specified under Section 190.60D shall be used. A center rod, plug, and pilot bit will be in place unless otherwise directed while advancing the hole by rotation but to a depth no greater than the sampling interval. The center rod, plug, and pilot bit shall be removed and the sample obtained by driving the sampler
450 millimeters into the undisturbed material below the bottom of the auger. When sampling below the water table, the Hollow Stem Auger shall be kept full of water or drilling fluid unless otherwise directed. The auger flights shall be 1.5 meters in length and the maximum sampling interval shall not be greater than 1.5 meters.

However, the sampling procedure of obtaining a sample at each change shall take precedent as specified in Section 190.61. If the hollow stem auger encounters cobbles, boulders or similar material and fails to penetrate the material after an attempt has been made, then the Engineer may direct the contractor to make the boring by other methods such as a drive sample boring. However, the Engineer will decide when and if this procedure will be employed. Logs, samples and other pertinent information will be as specified in Section 190 contained herein.

190.63 Core Borings.

This type of boring is made after the casing has been sealed on bedrock to prevent loose material from entering the hole and to prevent the loss of drilling fluid return, regardless of the type or types of material encountered. Core Borings into bedrock shall be accomplished by the diamond bit, rotary drilling method. The minimum distance of coring

into bedrock shall be 3 meters. The minimum diameter of acceptable core shall be 34.9 millimeters. Where rock cores are required, the coring shall be done with a Double Tube Core Barrel in runs of 1.5 meters or less.

Every effort and precaution shall be made by the Contractor to insure the best possible recovery and preservation of the rock cores.

Should the recovered length of core be less than 75% of the depth cored, the Contractor shall adopt measures as may be necessary to improve the percentage of recovery.

Measures to improve recovery may include changes in:

(1) Type of diamond bit.
(2) Rate of feed.
(3) Speed of rotation.
(4) Volume of cooling water.
(5) Style of core barrel.
(6) Depth of coring for each removal of core.
(7) Machine operator.
(8) Type of machine.

All recovered cores, including fragments, shall be carefully handled to avoid breakage. They shall be placed in wooden boxes furnished by the Contractor. Boxes shall be in accordance with details furnished by the Department.

Cores shall be placed in the box in consecutive order as they are removed from the core barrel. The trough containing each core shall be fully identified and marked to show the top and bottom of the core.

Upon completion of each core boring all information obtained, including a brief description of the rock type, length or run, length recovered, percentage recovered, coring time, type of barrel used, etc., shall be added to the log of the corresponding boring. The boxed cores and completed logs shall be delivered to the Research & Materials Engineer, as required under Subsection 190.21. All lengths and percentages recovered shall be verified by the Inspector.

190.64 Thin-Wall Steel Tube Drive Samples.

Where organic and inorganic clay or other soils are encountered while making a borehole, the Engineer may require the Contractor to obtain thin-wall steel tube drive samples. The tube shall not be less than 50.8 millimeters in diameter nor less than 450 millimeters long and need not be sharpened. The diameter of the thin-wall tube shall be specified in the special provisions. Making the borehole shall follow the procedure outlined under Subsection 190.60C. The steel tube shall be driven its full length into the material to be sampled. The loaded steel tube shall be sealed, marked for identification and handled in the manner described under Subsection 190.66.

190.65 Undisturbed Sample Preparatory Borings.

The results of Drive Sample borings will determine whether Undisturbed Samples are required and the elevations at which they can be obtained.

The applicable parts of Subsection 190.60C shall be followed in making this type of boring. The volume of mud circulated shall be increased just enough to transport the loosened soil from the borehole. The last 600 millimeters of borehole above the elevation at which an undisturbed sample is to be obtained shall be made with a bit built to deflect the flow of mud from a downward direction. Final preparation of the borehole to the top of each undisturbed sample shall be accomplished with a properly constructed and operated clean-out auger. The borehole shall be free of soil particles, soil shavings and settled solids to the surface of undisturbed soil and shall be full of mud to the overflow nipple at the top of the casing.

(1) Drilling Procedure.

"Open hole" techniques may be allowed for advancement of the borehole. When casing is used the diameter shall be at least 25.4 millimeters larger than the diameter of the undisturbed sample called for.

Independent of the hole advancement technique (casing or open hole) selected, heavyweight drilling fluid with a unit mass between 1200 and 1500 kilograms per cubic meter will be required. The unit mass employed will be selected by the Engineer or his/her representative in the field, based on hole depth and soil characteristics. The purpose of the drilling

fluid is to maintain hole stability and minimize sample disturbance.

(2) Drilling Fluid.

Drilling Fluid shall be produced using clean water and bentonite or one of its derivatives. The drilling fluid shall be mixed to a uniform consistency acceptable to the Engineer. A drilling fluid net mass of 1200 to 1500 kilograms per cubic meter (as determined by the Engineer) shall be obtained and thereafter maintained during execution of the borings, from which undisturbed samples are obtained. The boreholes shall be filled with drilling fluid; the fluid level shall be maintained above the ground or water surface at all times until the last sample is taken from the drill hole.

(3) Drill Rods

Drill rods provided for drilling, washing, and sampling within the borehole shall be of such a size that sufficient fluid flow (as determined by the Engineer) can be delivered to the bottom of the hole to permit complete flushing of soil when drilling at maximum depth. Drill rod fittings shall be provided to permit attachment of the drill rods to the thin wall tube sampler.

(4) Pump

The Contractor shall furnish a suitable pump capable of pumping and recirculating the weighted drilling fluid use for the depth and diameter of boring required.

The use of casing for Undisturbed Sample Preparatory Boring shall follow the procedure outlined under Subsection 190.60B. The casing shall have a nominal diameter at least 25.4 millimeters larger than that of the undisturbed sample called for in the Special Provisions. Drive Samples shall be obtained as directed by the Engineer.

Immediately after recovery of an undisturbed sample, as described in Subsection 190.66 the Inspector will examine the ends of the tube for adequacy and condition of the sample. If unacceptable, the borehole shall be re-prepared and additional samples taken until a satisfactory recovery is made.

190.66 Undisturbed Samples.

Undisturbed samples shall be obtained with a stationary piston, thin-wall, steel tube sampler operated by a separate piston rod (actuating rod) and a sampler head with an appropriate spring and piston rod cone check. The diameter of the undisturbed samples shall be as specified in the Special Provisions. The sampler must be kept in perfect mechanical condition and operated at all times in a manner that will produce acceptable undisturbed samples.

The Osterberg method for obtaining an undisturbed sample may be substituted for the stationary piston method, if approved by the Engineer.

The seamless steel tube shall have a wall thickness not greater than 1.65 millimeters. It shall be of a proper length to produce a net sample 600 millimeters long. Its bottom edge shall be drawn and reamed knife-sharp to an internal diameter approximately 1.75% less than the inside diameter of the tube. The tube shall be free of all scale or other deleterious material and may have a coat of thin enamel paint, lacquer, teflon, or other similar material. Just before being lowered to sample, the inside of the tube shall be wiped dry. Tubes with rusted surfaces shall not be used.

After being fully assembled and lowered to sampling position, the sampler shall be entered into the undisturbed soil by a rapid, continuous movement, without rotation.

A rest period of not less than 15 minutes shall be allowed for the sample to develop friction on the inside of the tube. The loaded tube shall then be rotated by turning the top of the drill-rod. A direct, slow and steady pull, accompanied by rotation, shall remove the loaded tube from the soil. Raising the tube to the surface shall be done without quick starts, sudden stops or vibrations. The borehole is to be kept full of mud during the entire recovery operation.

To free the loaded tube from the sampler-head, without damaging the sample, the vacuum breaker shall be opened. Immediately after the tube is freed, its end shall be inspected and if found satisfactory shall be sealed against loss of moisture.

The top and bottom of the tube shall be sealed with molten beeswax or a microcrystalline petroleum wax heated to a temperature not higher than its melting point. The total thickness of seal shall be approximately 20 millimeters. Any space remaining at either end shall be filled to within 20 millimeters of the end of the tube with firmly pressed damp sand. Sealing wax shall then be poured flush with the end of the tube, which shall be covered with several layers of electrician's tape.

A paper label, on which is recorded in ink all pertinent information as required in Subsection 190.61 relating to the contained sample, shall be glued to the tube. The same data shall be printed directly on the tube with a felt-tip marker

of a contrasting color.

The loaded tubes shall be packed in well built wooden boxes at the sampling site. Each box shall contain not more than one 127 millimeter nor more than two 76.2 millimeter or four 50.8 millimeter tubes. Each tube shall be surrounded by at least 50 millimeters of resilient packing. A record of its contents shall be marked on the lid of each box with a felt-tip marker. The boxes shall be delivered at the completion of each borehole as directed in writing by the Engineer.

An acceptable undisturbed sample for laboratory tests shall, when split in two longitudinally and partially dried, disclose no observable distortions in its stratifications and/or shear planes that can be reasonably attributed to the sampling and handling operations. The Engineer may direct the Contractor to alter the cutting edge clearance of the sampling tube.

Where undisturbed samples are to be taken over water (tidal or otherwise), the Contractor shall have the necessary equipment to properly obtain an undisturbed sample on water and have the necessary devices to stabilize the barge or raft while making an undisturbed sample.

190.67 Vane Shear Test Preparatory Borings.

The borehole shall be made under applicable parts of Subsection 190.60C and 190.65 to a point 1.2 meters above the elevation at which a vane shear test is to be made. The next 600 millimeters of borehole shall be made with a bit built to deflect the flow of mud from a downward direction. By means of a clean-out auger built for the purpose, all soil and shavings shall be removed to an elevation 300 millimeters above the position of the top of the vane tool during the test. Drive samples shall be obtained as directed by the Engineer.

190.68 Vane Shear Test.

The in-place shear strengths of cohesive soils shall be measured by means of field vane shear tests. The Contractor shall have the required vanes as specified in the contract.

The penetrating edge of the vane blade shall be sharpened having an included angle of 90 degrees. A ball bearing casing guide shall be attached to the drill rods 600 millimeters above the vane and additional ball bearing casing guides shall be provided for each 6 meters of drill rods required thereafter. All drill rods shall be made up tightly. The vane shall be pushed into the soil below the bottom of the hole in a manner that will prevent rotation during insertion. The bottom of the vane shall be inserted 450 millimeters into the undisturbed soil at the bottom of the hole.

After insertion, the drill rods shall be clamped securely to a thrust type ball bearing reacting against the casing, this bearing should support the entire weight of the vane and rods during test. A rotation of the vane shall be accomplished by means of a mechanical gear driven mechanism which shall produce a uniform rate of rotation of about 1 degree every 10 seconds (6 degrees per minute). Accurately calibrated torque mechanism or proving rings with maximum readings of 65 newton-meters shall be provided to measure the applied torque. Acceptable equipment is the Acker Precision Drive, Barros, Geonor, Sprague & Henwood, or approved equal in good working condition. Torque wrenches will not be allowed. Calibration of Vane Shear Equipment by an acceptable organization capable and specializing in this work will be required. If said equipment has been calibrated and checked within the last six months by a recognized laboratory no additional calibration will be necessary. Certificate of Proof will be required.

A friction check will be run prior to each test when directed by the Engineer.

One man shall rotate the vane while the Engineer observes the torque gauge. Special attention shall be given to determine the maximum torque registered.

Following the determination of the maximum torque the remolded shear strength shall be determined in the same manner after rapidly rotating the drill rods about 12 revolutions. The determination of the remolded strength should be started immediately after completion of the rapid rotation and in all cases within one minute after the remolded process.

During the tests, readings of time, applied torque and angular rotation should be recorded at 15 sec. intervals unless otherwise directed until the maximum torque is achieved. The maximum torque in newton-meters, the time and angle of rotation measured from the start of the test to the development of maximum torque shall also be recorded. A complete description of the apparatus and detailed dimensions of the vane shear tool shall be submitted with the test report.

Completion of the procedure described above including determination of the remolded shear strength shall

constitute one (1) field vane shear test for payment purposes.

If the Contractor is unable to push or drive the vane into the soil below the bottom of the hole after lowering the drill rods and vane to the required depth or if the Contractor is unable to rotate the vane to determine the maximum torque due to the stiffness of the soils or due to an obstruction, compensation will be considered included in the Unit Bid Price per meter for Vane Shear Test Preparatory Boring and no further compensation will be made.

190.69 Auger Borings.

Auger borings shall be made where directed to obtain large volume soil samples for laboratory testing. The borings shall be made to depths required by the Engineer, with an earth auger not less than 100 millimeters in diameter, either manually or power operated. The auger section shall not exceed 1.5 meters in length and shall be removed from the auger hole each time its hollows have become filled with soil.

190.70 Auger Boring Samples.

Large volume soil samples for laboratory testing shall be obtained from auger borings. Each sample shall have a mass of at least 25 kilograms and shall be preserved in an approved container. The number of samples required at each borehole shall be determined by the Engineer.

The container for each sample shall have positive identification of the contents, either by typewritten glued-on label, by wired-on tag or by felt-tip marker. The following information shall be shown:

1. Name and address of boring contractor.
2. Date sample was taken.
3. Location and name of project.
4. Location of auger borehole by station and offset or identifying number of auger borehole, if so identified on plan.
5. Depth below ground surface at which sample was obtained.

190.71 Ground Water Observation Wellpoints.

Type I – A 63.5 millimeter minimum diameter hole shall be advanced by the Contractor by whatever method he/she chooses to the elevation specified regardless of type of material encountered such as boulders, "Practical Refusal" material, rock fill, etc., with the exception of bedrock. When the bottom of the hole has reached the elevation specified for the tip of the wellpoint, it shall be purged to its full depth with clean water.

The wellpoint shall have ample clearance so that it may be lowered freely in the borehole. The screen shall be 250 micrometer mesh unless otherwise stated. The minimum dimension of the wellpoint shall be 32 millimeters x 610 millimeters. The riser, rigidly fastened to the wellpoint, shall be 32 millimeter galvanized pipe. A galvanized pipe plug or a cap with a vent hole shall be furnished to close the top of the riser. After the wellpoint has been lowered to the specified elevation, the annular space between the wellpoint and riser pipe and the 65 millimeter casing shall be filled with clean, dry sand, unless otherwise directed. This sand shall be retained on a 300 micrometer sieve and shall pass a 600 micrometer sieve. It shall be poured in slowly to fill the annular space as the casing is pulled.

During the pulling of the casing the wellpoint shall not be raised from its original position.

At completion, the top of the riser pipe shall be closed wrench tight with a vented pipe plug or cap.

Type II – Ground Water Observation Wellpoints Type II may be installed in a completed borehole after all samples and information have been obtained from these holes. Prior to placing the wellpoint, these holes shall be purged to their full depth with clean water. Where the bottom of the borehole is lower than the highest bottom elevation of the wellpoint, that portion of the borehole below the bottom of the wellpoint shall be backfilled with a clean dry sand to the elevation of the bottom of the wellpoint unless otherwise directed. If the bottom of the casing is below the highest bottom elevation of the wellpoint when the sand has reached the elevation of the bottom of the casing, the backfilling and pulling of casing shall be carried out simultaneously to the highest bottom elevation of wellpoint and continued as directed for Type I Ground Water Observation Wellpoints unless otherwise directed.

Backfilling of boreholes below bottom of wellpoint, where required shall be included in the cost of Ground Water Observation Wellpoints Type II. Where bedrock is encountered the diameter of the borehole and rock core shall be large enough to accommodate a wellpoint and riser pipe.

Type III – Ground Water Observation Wellpoints Type III wellpipe and screen shall be installed as described in these specifications for Type I Ground Water Observation Wellpoints, except that the wellpipe and screen used shall be 50 millimeter P.V.C. schedule 40 threaded flush joint wellpipe and wellscreen. Wellscreen slot width shall be 0.25 millimeter. A suitable threaded plug shall be installed at the bottom of the wellscreen. A suitable vented thread cap shall also be installed at the top of the well pipe when requested by the Engineer. No cementing will be allowed. The length of the wellscreen for each Type III Ground Water Observation Wellpoint will be designated on the plan by the Engineer. Separate payment will be made for the wellpipe used and the wellscreen used.

The hole made shall be of sufficient diameter to accommodate the wellpipe and screen.

Type IV – Ground Water Observation Wellpoint Type IV wellpipe and wellscreen may be installed in a completed borehole after all samples and information have been obtained from these holes. The method of installation shall be the same as described in these specifications for Type II Ground Water Observation Wellpoints except that the wellpipe and screen used shall be 50 millimeter P.V.C. schedule 40 threaded flush joint wellpipe and wellscreen. Wellscreen slot width shall be 0.25 millimeter. A suitable threaded plug shall be installed at the bottom of the wellscreen. A suitable vented threaded cap shall be installed at the top of the well when requested by the Engineer. No cementing will be allowed. The length of the wellscreen for each Type IV well will be designated on the plan by the Engineer.

The borehole shall be of sufficient diameter to accommodate the wellpipe and screen. If bedrock is encountered the corehole shall be large enough to accommodate the wellpipe and screen.

When directed by the Engineer, sand may be omitted on all types of well installation.

190.72 Mobilization and Dismantling of Boring Equipment.

This work shall include the furnishing at the site of all men and equipment necessary to properly complete the work detailed in the Proposal, including the moving of men and equipment from one project site to another and the restoration of each site after the boring equipment has been removed. It shall also include all special tools and equipment necessary to perform the work in or on water and in other places not readily accessible.

190.73 Test Pits.

Dimensions of Test Pits will be such that a 25 kilogram sample can be obtained at depths specified. The pit can be dug by hand or machine at locations as directed by the Engineer. In no case will the depth of pit be more than 3.5 meters. Test Pits shall be properly sheeted to protect the workers as required in Subsection 140.60, Paragraph F, and shall be large enough to allow the inspection of soil conditions and/or the procurement of 25 kilogram bag samples. (Maximum number not to exceed three (3).)

Each sample shall have a mass of at least 25 kilograms and shall be preserved in a suitable and approved container.

The container for each sample shall have positive identification of contents either by typewritten glued-on label, by wired-on tag or by felt-tip marker. The label shall be covered completely with a transparent material such as tape, plastic, etc.

The following information shall be shown:

1. Name and Address of Boring Contractor.
2. Date Sample was taken.
3. Location and name of Project.
4. Location of Test Pit by Station and Offset or Identifying No. if so identified on plan.
5. Depth below ground surface at which the sample was obtained.

When the test pit is completed and required samples taken and approved by the Engineer, it shall be backfilled and compacted in an approved manner so as not to cause a hazardous condition.

Test Pits Through Pavements

When test pits are required where the Contractor must break through pavements, he/she shall make as small a test

pit as possible. After the Contractor obtains the proper number of samples required he/she shall backfill the test pit with suitable material, and compact it in accordance with the Standard Specification. The test pit then shall be brought to the proper grade with the last 160 millimeters being bituminous concrete or cement concrete whichever is applicable. The cost of patching where required shall be included in the cost of the test pit.

Test pits made through pavements shall be cut on a neat line by a jack hammer, saw or other mechanical means. The cost of cutting the pavement on a neat line by jack hammer, saw or other mechanical means and patching the pavements as required shall be included in the unit bid price for test pits made through pavements.

COMPENSATION

190.80 Method of Measurement.

Drive Sample Borings and Hollow Stem Auger Borings when completed as such, will be measured by the meter of borehole made in original and trial borings below the ground surface, regardless of the type of materials encountered, such as boulders, "Practical Refusal" material, rockfill, etc. with the exception of bedrock.

Core Borings will be measured by the meter cored into bedrock.

Undisturbed Sample Preparatory Borings and Vane Shear Test Preparatory Borings will be measured by the meter of borehole made below the ground surface to the lowest undisturbed sample made or Vane Shear Test performed.

Thin-wall Steel Tube Drive Samples, Undisturbed Samples, Auger Boring Samples and Vane Shear Tests will be measured for each acceptable sample recovered or test made.

Auger Borings will be measured by the meter of borehole made below the ground surface.

Ground Water Observation Wellpoints Type I and Type II will be measured by the meter from the tip of the wellpoint to the top of the riser pipe, but not more than 600 millimeters above the ground surface regardless of the type of materials encountered such as boulders, "Practical Refusal" material, rockfill, etc., with the exception of bedrock.

Ground Water Observation Wellpoints Type III and IV wellpoint will be measured by meter from the top of the wellscreen to the top of the riser pipe but no more than 600 millimeters above the ground surface regardless of the type of materials encountered such as "Practical Refusal," Boulders, Rock Fill, etc., with the exception of bedrock. Ground Water Observation Wellpoints Type III and IV wellscreen will be measured by the meter from the bottom of the wellscreen to the top of the wellscreen or the actual length used regardless of the type of materials encountered such as Boulders, "Practical Refusal," Rock Fill, etc., with the exception of bedrock.

Test Pits will be measured by each Test Pit made.

190.81 Basis of Payment.

Drive Sample Borings, Hollow Stem Auger Borings, Core Borings, Undisturbed Sample Preparatory Borings and Vane Shear Test Preparatory Borings will be paid at the contract unit price per meter for the kind of boring completed as required: payment to include installation of casing as required, including telescoping and spinning of casing when necessary, recovered cores and drive samples. Payment for Undisturbed Preparatory and/or Vane Shear Test Preparatory will only be made to the lowest undisturbed sample made or to the last Vane Shear Test performed. If the boring is continued beyond this point it shall be paid as a Drive Sample boring or other type for the remainder of the borehole or as specified in the Special Provisions.

When borings are located on the water, payment shall be made at the contract unit price per meter for the type of boring made only for the depth of hole below the river, lake, stream, etc., bottom.

Auger Borings will be paid at the contract unit price per meter completed as required.

The cost of any materials required to restore the site to its original condition will be included in the unit price of the item.

Ground Water Observation Wellpoints Type I and Type II will be paid at the contract unit price per meter which shall include full compensation for a log and all materials left in place.

Ground Water Observation Wellpoints Type III and IV wellpipe and wellscreen will be paid at the contract unit bid price per meter which shall include full compensation for a log and all materials left in place.

Thin-Wall Steel Tube Drive Samples, Undisturbed Samples, Auger Boring Samples and Vane Shear Tests will

be paid for at the contract unit price for each acceptable sample or test completed as required.

Mobilization and Dismantling of boring equipment will be paid for at the contract lump sum price for Item 193.

Test Pits will be paid at the contract unit price for each test pit actually dug. The contract unit price shall include all labor, equipment, supplies, tools and incidentals required to dig the test pits. The cost for any material to restore the site to its original condition and cutting through pavements will be included in the Item. The Unit Bid Price shall also include the cost of obtaining 25 kilogram bag samples (maximum number of 3) as directed and all other incidental work thereto, including a log.

190.82 Payments Items.

191.	Drive Sample Boring	Meter
191.10	Hollow Stem Auger Borings	Meter
191.11	Core Boring	Meter
191.2	Undisturbed Sample Prep. Boring	Meter
191.21	Undisturbed Sample	Each
191.3	Vane Shear Test Prep. Boring	Meter
191.31	Vane Shear Test	Each
191.4	Auger Boring	Meter
191.41	Auger Boring Sample	Each
191.5	Thin Wall Steel Tube Drive Sample	Each
191.6	Test Pit	Each
191.61	Test Pits through Pavements	Each
192.	Ground Water Observation Wellpoint Type I	Meter
192.1	Ground Water Observation Wellpoint Type II	Meter
192.2	Ground Water Observation Wellpoint Type III – Solid Pipe	Meter
192.21	Ground Water Observation Wellpoint Type III – Wellscreen	Meter
192.3	Ground Water Observation Wellpoint Type IV – Solid Pipe	Meter
192.31	Ground Water Observation Wellpoint Type IV – Wellscreen	Meter
193.	Mobilization and Dismantling of Boring Equipment	Lump Sum